as well as the bracteolae smooth. Male flowers central pedicellate. Sepals smooth, the three externals coherent at the base; the three internals concert in a long tube, the free lobes bearing a gland. Stamens six inserted to the limbus. Anthers bilocular, introrse. Female flowers marginal on short pedicels, destitute of a calyx. Style, one, short, with three filiform stigmata. Capsule smooth, tricoccous, loculicide dehiscent. Seeds in the cells solitary, smooth, not costulate, of the structure of Eriocaulon.

This genus is chiefly characterised by the want of the floral envelope in the female flowers, but agrees otherwise in habit and structure with Eriocaulon. The name is derived from the colour and shining transparency of the seeds, not unlike that of amber.

50. *Electrosperma Australasicum.*

On wet places along the Murray, towards the junction of the Murrumbidgee.

A small annual scapebearing herb. Leaves grass-like, fenestrate nerved, pellucid. Scape monocephalous, vaginat at the base.

ART. III.—*On the comparative value and durability of the Building Materials in use in Melbourne. By Robert Brough Smyth.*

THE selection of building materials has always been a work of difficulty, as indeed is every branch of knowledge, where the experience of a single individual is substituted for those simple principles which arise naturally from an accumulation of facts,—not the records of one life time, but of many,—not of one department of science, but of all. The mistakes that have been made from time to time, as evidenced in the decay of some of the finest architectural works in Europe, have drawn considerable attention to the subject of late years; and that such mistakes may, in a great measure, be provided against, if not wholly prevented, we have the evidence of the Scientific Commission appointed to examine the stone to be used in the New Houses of Parliament, and of the Corps of Royal Engineers, whose sound and practical observations, founded on actual experiments, are worthy of the highest consideration.

It not only has immediate reference to the conservation of those edifices wherein the genius of the architect is paramount, but is so connected with our wants and necessities, of a common kind, that we cannot but injuriously sacrifice it to consideration of cost, time, and convenience.

As this paper will treat more particularly of the building materials used in Melbourne, it is necessary to remark that the geological character of the district is similar to that from whence are derived some of the best building stone in Great Britain. The prevailing formation is inclined sandstone and clay slate, changing so much in its lithological character that, had we not clear and satisfactory evidence of its antiquity, it might sometimes be mistaken for a recent deposit. We find it in every variety of sandstone, from a coarse grit to that of a fine, close-grained structure, which last passes into a claystone, containing very few quartz grains, and a little white mica.

Overlying this, and extending through a considerable area, is the Basalt, or "Bluestone," which is well adapted to structural purposes, and generally obtains where durability is desired. The rock is recognised by geologists as a volcanic product, and may be considered second only to the Plutonic rocks, in its wide distribution and economic importance.

Basalt.

The specimens that I have examined differ very little in their composition as far as it effects their durability; though the proportions of their chemical constituents are variable. It is composed of angite, felspar, iron, and lime, with occasional crystals of olivine; and the contact of these minerals is close and perfect. The most common colour is greyish blue. The fracture is uneven. An analysis shows its component parts to be—*

Silex	50
Alumina	22
Carbonate of Lime ..	10
Magnesia	4
Iron	10
Loss	4

It sometimes contains traces of other metals, but this analysis gives its most important constituents. The average weight of a cubic foot is 165 lbs., the maxium being 167 lbs., and

* The figures in this analysis must be considered only as approximate; my appliances not being of a kind to ensure rigid accuracy.

the minimum 164 lbs. It does not absorb so much water as might be supposed from its structure. After immersing an average specimen for 96 hours its increment in weight was 1·751 per cent.; and a mean of various experiments made on stones procured from the neighbouring quarries approach very nearly to this result. Were it not that this stone was exceedingly costly, both in obtaining it from the quarry, and in all its subsequent stages, it would be used in this Colony in preference even to granite.

In addition to its value as a building stone, it is quarried for road metal and kerbstones, for which it is peculiarly adapted, and that is perhaps the best proof of its durability.

The styles of architecture adopted in Melbourne, where Basalt is used, are not generally favorable to its appearance; where it has received some degree of finish it is extremely handsome, and it is to be regretted that it has not been chosen for our public buildings.

Basalt may be advantageously employed in the composition of mortar. When it is calcined and reduced to powder, it imparts to the cement the property of hardening under water.

Sandstone.

The Sandstones which I have examined are by no means favorable specimens of the formation which they represent. In general they have been procured at or very near the surface, and from the quality and properties of such specimens very erroneous opinions have been formed of their nature.

In the older formations, and here I would allude to an age antecedent to the Carboniferous era, it must be remembered that the surface of the strata has been exposed for countless ages to incessant changes; and the alterations which it has undergone will extend to various depths in exact proportion to the structure of the rock.

The term "metamorphic," as used by geologists, is applied to rocks which have been altered by the effect of heat. Little attention has been paid to changes which take place by infiltration, by the decomposing effects of air and water, and other causes, requiring lengthened periods of time for their completion.

Inclined strata, of a schistose structure, are more liable to such alteration than the comparatively undisturbed deposit of a coal basin; and though I am far from attributing the perishable nature of the Melbourne Sandstones wholly to these causes, they undoubtedly have exercised an influence more powerful than we are at first inclined to admit.

The Sandstone procured from Irrewarra, in the parish of Boroondara, singularly contrasts will other beds in the immediate vicinity. Though, as will be shown, it is neither so durable nor so valuable in other respects as the Geelong Sandstones, it is a proof that the changing character of the beds needs only to be noted and followed to lead to other deposits of a better description.

The block which has been handed to me for examination is composed of coarse quartz grains, much water worn, agglutinated by an argillaceous and siliceous cement. Its shades vary from pale cream color to nearly pure white, and it is irregularly traversed by red and brown ferruginous streaks and spots. It yields readily to the hammer in the direction of its cleavage, as is usual with stones of this class. The average weight is 155 lbs. per cubic foot. Its capacity of absorption is so great that that alone is a sufficient reason for its rejection as a material for large buildings. After immersing a portion of the block, weighing 55·85 ozs. for 72 hours it absorbed 3·043 per cent. by weight, and another experiment on a smaller piece gave 3·217 per cent. By simple immersion, allowing it to remain till air bubbles had ceased to escape, the results were as follows:—

Experiment, No.	1,	2·542	per cent.
„	2,	2·320	„
„	3,	2·194	„

Thus, it only absorbs a large amount of water, but what speaks more strongly in its disfavor, such absorption is carried on very rapidly.

This stone has been subjected to a variety of tests, some of which it is necessary to particularize. A small specimen of the average quality was immersed in a solution of a carbonate till it had absorbed the maximum quantity ; it was then placed in a weak solution of acid : this gave rise to brisk effervescence, and frequent repetitions of this resulted in the destruction of the surface of the stone. This test I have found valuable in practice : it is needless to state that it can only be used when the cement is not of a calcareous nature.

Another series of tests were instituted by immersing the stones in solutions of various salts, and then suspending it over the vessel containing the fluid. After this process was many times repeated the salt re-crystalized in the stone ; and the mechanical force thus exerted very gradually effected the disintegration of the surface.

A good building stone would long resist such experiments, for it it is manifest that if the amount of water absorbed was inconsiderable, the mere crystallisation of the salt upon the surface would produce little or no change. In estimating the durability of a building-stone it is particularly necessary to note what quantity of water it will absorb, and whether it long retains moisture. This is a matter of primary importance where the frosts are severe and of long continuance, and it ought not the less to enter into our calculations, for we have climatic variations in this country which tend almost as rapidly to disintegration.

Water requires its greatest density between the temperatures of 39° and 40° Fahrenheit, from which point both heat and cold cause expansion. Here, where we have sometimes a deluge of rain succeeded by extreme heat, it follows that the mere expansion of the fluid rapidly exerted, must cause the destruction of an absorbent body.

If we observe the rocky bed of a river or creek where the water and the sun have alternately acted upon the stone it will be seen that the surface is, in every case, in a state of decay, sometimes to the depth of several inches. This illustration is drawn from the highly indurated Trappean rocks which abound in our neighbourhood. How much more liable are the ordinary Sandstones to such influences. We must also take into account the dew which falls very heavily throughout some months of the year. Moisture absorbed in such a state will tend to lower the temperature of the walls, and that again is as quickly raised during the day. It is the continual repetition of these influences which ultimately destroys the cohesion of bodies so constituted.

An accurate analysis of the Boroondara stone would give those constituents which are found in some of the best Sandstones, but that does not in itself afford us criteria whereby we may judge of its value. It is more dependent upon the mechanical structure, due to compression, and the unretarded progress of those chemical changes which tend to consolidate the mass.

My meaning may be better understood by examining its fracture. We do not find the particles of quartz shivered and split, but they uniformly separate from the cement, leaving perfect casts of the imbedded grains.

The freedom with which this stone may be wrought into almost any shape, and its cheapness compared to basalt or limestone, render it suitable for cottages or other small buildings, where there is no great pressure on the walls; but all building stones of similar properties ought to be rejected in extensive erections.

The Toorak sandstone, as I am informed, is from the same formation as that of Boroondara. It is composed of very fine water worn quartz grains, and minute plates of white mica, with an argillaceous base. It is deeply tinged with iron oxide in patches and streaks; none of the specimens in my possession being of a uniform colour. The weight of a cubic foot is 145 lbs.—the maximum being 147 lbs., and minimum 143 lbs. It is easily frangible. It may be wrought in large masses. It absorbs water very quickly, and to a great extent. It gains 3·952 per cent. by weight if immersed for a few minutes; and a piece that was placed on its end in water for ninety-six hours showed an increment by weight of 5·109 per cent. In comparing the sandstones, one with another, it will be observed that some very rapidly absorb their maximum quantity of water, and others very slowly. The close grained sandstone from Geelong, for instance, gains ·336 by simple immersion, but the actual amount that it will absorb, if sufficient time is allowed, may be stated at 3·831.

Subjecting the Toorak stone to the usual tests it is soon destroyed. Such of the specimens as I have met with are not suitable for building purposes, all of them possessing features similar to the above. A small piece that was placed in a vessel containing sufficient water to moisten the lower portion, was soon completely saturated, the cavities of the stone acting like so many capillary tubes. With such a stone for outer walls a house would be always damp and cold in winter; a matter of deep importance to the health and well-being of the occupants, which ought ever to enter into calculations of this kind.

A deeper section of this quarry may probably afford a less perishable material, and such a discovery would be of the greatest value at the present time.

For durability, beauty, and economy, the sandstones are undoubtedly of the first class.

The lightness, and architectural elegance of the buildings in Edinburgh, which are so famous, are due to the circumstance of the sandstones there being procurable of a superior quality. Perhaps it would be impossible to construct such edifices of any other material, which at once combines hardness, strength, and impermeability, with a peculiar richness of effect.

As an example of the waste of labour and capital which sometimes results from using an untried sandstone, I may cite the case of an enterprising citizen of Melbourne, who some ten years ago built an hotel of a material quarried from the extensive formation to which the Boroondara stone belongs. Within three years after its completion the stone was found to be so far decayed that it became necessary to protect the walls with a facing of another material. This is sufficient to illustrate the practical utility of inquiries such as these.

Major-General Sir John Burgoyne, in speaking of this class of stones, has thus expressed himself:—"From the nature of the composition of sandstones, it results that their resistance against or yielding to, the decomposing effects to which they are subjected, depends to a great extent, if not wholly, upon the cementing substance by which the grains are united; these latter being comparatively indistructible. . . . . . Uniformity of colour is a tolerably correct criterion of uniformity of structure, one of the practical excellences of "building stones."

Bricks.

The great effects attending the working and procuring of building stone in this City, has led to the adoption of Bricks as a convenient and ready substitute. Very little attention has been paid to their manufacture, as a detail of the following experiments will show.

I have procured my specimens from large buildings which are at present in course of erection, with the hope of drawing attention to a matter of such importance.

These Bricks are composed of clay which has resulted from the decomposition of clay slate and Basaltic rocks, and that again is mixed with a large per centage of siliceous earth, washed down from the more recent formations which form the capping of the adjacent hills.

The fracture is rugged and uneven, showing the presence of embedded quartz pebbles, with occasionally pieces of unmixed talcose clay of a pure white colour. They are light and porous, and readily yield in any direction to a slight blow.

The specific gravity is 2·078, and compared with other Bricks is as follows:—

Ramsay's Fire Brick, Newcastle-on-Tyne,	2·204
White Brick, Launceston, ...	2·153

They absorb water very rapidly: one specimen gaining 11·523 per cent. by weight in 20 hours, and another 13·257 per cent. When it had absorbed its maximum quantity it was easily crumbled between the fingers. A good brick does not absorb so much water as the Melbourne sandstones. One of Ramsay's manufacture was immersed for 20 hours, and its increment was 2·841 per cent., and after 72 hours 3·216 per cent. Subjected to the ordinary tests the common red Brick very rapidly disintegrates. It may be inferred that a small amount of force would be required to crush it; and it is a matter of regret that I have no present means of ascertaining the exact weight. Such a material is certainly not suited for buildings three stories high; and yet a considerable number of houses in this City are so constructed.

There is a very slight difference in the quality of the Melbourne Bricks. The fault is owing not so much to the material of which they are composed, as to the improper manner in which they are manufactured. They are usually burnt in clamps, and the clay is not ground and tempered as is customary in other countries. If suitable kilns were erected, and care was taken in the preparation of the raw material, it would be possible to make as good Bricks in Melbourne as any that are imported, excepting perhaps the fire bricks.

Bricks which are made of pure clay, and heated to vitrification, have been found to resist atmospheric influences most completely. Such a material is unsuitable for high walls, as its cohesive strength is not so great as when a proportion of sand is used. The best English bricks are manufactured from a clay which contains about one-fourth of sand, and if it should contract considerably in burning, the proportion of the latter is increased. Much of the fine clay around Melbourne contains lime and magnesia, but not in excess; and if it were mixed with the superficial clay at present in use, a manifest improvement would be apparent in the bricks. All materials of this manufacture are rendered more durable by glazing. This is effected by throwing a due proportion of salt into the furnace, the result of which is the vitrification of the outer crust. When the manufacture is otherwise imperfect, this system, if properly conducted, will lessen the tendency to decay, and obviate the unsightly and expensive system of painting, which is often resorted to in Melbourne. Not until we have the same spirit that animates the manufacturers in England and America will this branch of industry, be fully developed. Machinery has there superseded the slow and tedious operations of hand moulding and smoothing, and the work of one man is now equivalent to that of six under the old style. The fashioning of bricks is not the only use to which the plastic clays are adapted. The fabrication of draining pipes and tiles employs a large capital in England, and the success which has there attended the manufacturer has been of incalculable value to the Agriculturist. It has sufficed to bring under cultivation many thousand acres of land, thereby increasing the demand for labour in all classes, and proportionably lessening the evils due to a surplus population.

The Melbourne bricks, as they are now manufactured, will be too costly when we shall have brought in the aid of machinery. With the ordinary appliances, a mill, a moulding machine, and kilns, the clay in this neighbourhood could be wrought into pipes for sewerage, flower-pots—indeed into every article, whether of utility or ornament, for which there is such a demand; and not of an inferior quality, but quite equal to what is imported.

If time permitted I would willingly advert to the manifest dangers attending the use of ill-burnt bricks in large buildings, such as hotels, stores, &c., &c. It is not a matter entirely confined to the occupant and the proprietor. Many of these edifices abut upon our public streets and promenades, and though in all probability the greater number of them will be taken down ere many years pass away, it would be a much better state of things if done forethought preceded their erection.

In concluding this paper, I would beg reference to the accompanying Table, wherein I have stated as accurately as possible, under present circumstances, the most characteristic properties of the Melbourne Building Materials:—

TABLE OF EXPERIMENTS ON BUILDING MATERIALS.

	Mean Specific Gravity.	Maximum Capacity of Absorption per Cent.	Minimum Capacity of Absorption per Cent.	DESCRIPTION.
Granite—Geelong (?)	2·688	0·153	0·017	Composed of felspar and quartz, with a large proportion of black mica. Cohesion generally perfect. Not of good quality, as the mica rapidly exfoliates. Colour greyish-white. Some varieties of the Geelong granite are very durable.
Basalt—Melbourne	2·650	1·751	0·518	Close texture. Fracture uneven. Good quality.
Sandstone—Geelong	2·329	3·831	0·336	Coal Measures. Fine quartz grains, with mica, felspar, and these minerals decomposed.
				Bituminous matter and iron. Argillaceous cement. Colour greyish-brown.
Sandstone—Boroondara	2·480	3·703	2·542	Coarse quartz grains, and a little mica. Argillaceous and siliceous cement. Colour, yellowish-white with ferruginous streaks and spots.
Sandstone—Toorak	2·290	5·300	3·952	Fine quartz grains and small plates of white mica, with an argillaceous base. Colour irregular. Light and dark ferruginous brown.
Limestone—Geelong	2·622	1·670	0·493	Magnesian. Very suitable for building purposes. Colour, greyish-yellow.
Fire Brick—Newcastle-upon-Tyne	2·204	5·216	2·796	Composed of ordinary fire-clay. Vitrified. Fracture sharp and clean.
White Brick—Launceston	2·153	10·858	7·717	Composed of a fine clay with little of foreign admixture.
Red Brick—Melbourne	2·078	13·854	9·950	Composed of clay and siliceous earth. Fracture rough and uneven.